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LITODONTA HYDROMELI HARVEY (NOTODONTIDAE): DESCRIPTION OF LIFE STAGES

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ABSTRACT. *Litodonta hydromeli* defense structures, mandibular morphology, feeding behaviors and setal morphology differ among instars. The third abdominal SV1 seta is twice as long in the first than in later instars. Later instars have numerous, scattered secondary setae. First instars skeletonize leaves with forklike mandibles. Subsequent instars ingest entire leaves, and their mandibles have a thin, ridged, cutting edge. First instars possess elaborate prothoracic scoli and dorsal spines which are progressively reduced in later instars as a prothoracic gland develops. Larvae spray an acidic substance which deters ants. *Litodonta hydromeli* feeds on *Bumelia* species (Sapotaceae) and developed indoors from egg to prepupa in six weeks. Adults reproduced readily in captivity.

Additional key words: Heterocampini, ontogeny, immatures, defense gland.

Notodontid adults have been described as medium-sized, noctuidlike moths (Forbes 1948), and probably have been neglected in ecological and systematic studies due to their plain appearance. The caterpillars, however, are notable for their bizarre shapes and developmental changes (ontogeny) (Packard 1895, Holloway 1983). As early as 1895, Packard recommended studies of larval ontogeny for systematic purposes. Although coloration and gross morphology have been described for several notodontid immatures (Peterson 1948, Dyar 1904, Godfrey 1984, Godfrey & Appleby 1987), detailed information of setal arrangement and larval ontogeny is lacking for most species.

Litodonta hydromeli Harvey is a north temperate representative of the tribe Heterocampini, and the species occurs in Florida, Texas, Oklahoma and Missouri (Harvey 1876b, Kimball 1965, Stephen Passoa pers. comm.). Harvey (1876a, 1876b) and Packard (1895) gave general descriptions of adult habitus. *Litodonta hydromeli* is figured in Holland (1903, plate 39, fig. 20), Kimball (1965, plate 20, fig. 3), and Packard (1895, plate 5, fig. 16). Dyar (1904) described the eggs and last instar, and gave *Bumelia angustifolia* (Nutt.) (Sapotaceae) as the larval host. Like some other Heterocampini, *Litodonta hydromeli* transforms from a spiny first instar to a cryptic fifth instar with a cervical defense gland (Herrick & Detwiler 1919, Eisner et al. 1972, Weatherston et al. 1979).

The purpose of this paper is to detail larval, pupal, and adult morphology of *L. hydromeli*, and to discuss changes in larval defense structures and feeding biology during development.

METHODS

Adults were taken at blacklights at Austin, Texas, in March 1983, March 1984, September 1985, and April 1986. Females (culture Nos.

W84-102, WE85-25, and WE85-37) were placed in jars and eggs obtained. I reared cultures at 24°C on the leaves of *Bumelia lanuginosa* (Michx.) and an unidentified *Bumelia* species in the laboratory. Eggs and subsequent immature stages were preserved in 80% ethanol. Third, fourth, and fifth instars were killed in simmering water before preservation. Shed head capsules were preserved, and some treated with 10% KOH, dehydrated, and slide mounted for study of chaetotaxy. First and second instars were cleared with cold KOH or 2% trisodium orthophosphate, then stained with chlorozol black (Kodak or ICN) dissolved in 20% ethanol. Means are followed by the range in parentheses, except where ranges do not exist. Setal nomenclature follows Hinton (1946). Male and female genitalia, and male appendages were softened in KOH, dissected in 40% ethanol, and stained. Preparations were mounted in Canada balsam. Voucher specimens are in the National Museum of Natural History, Washington, D.C.

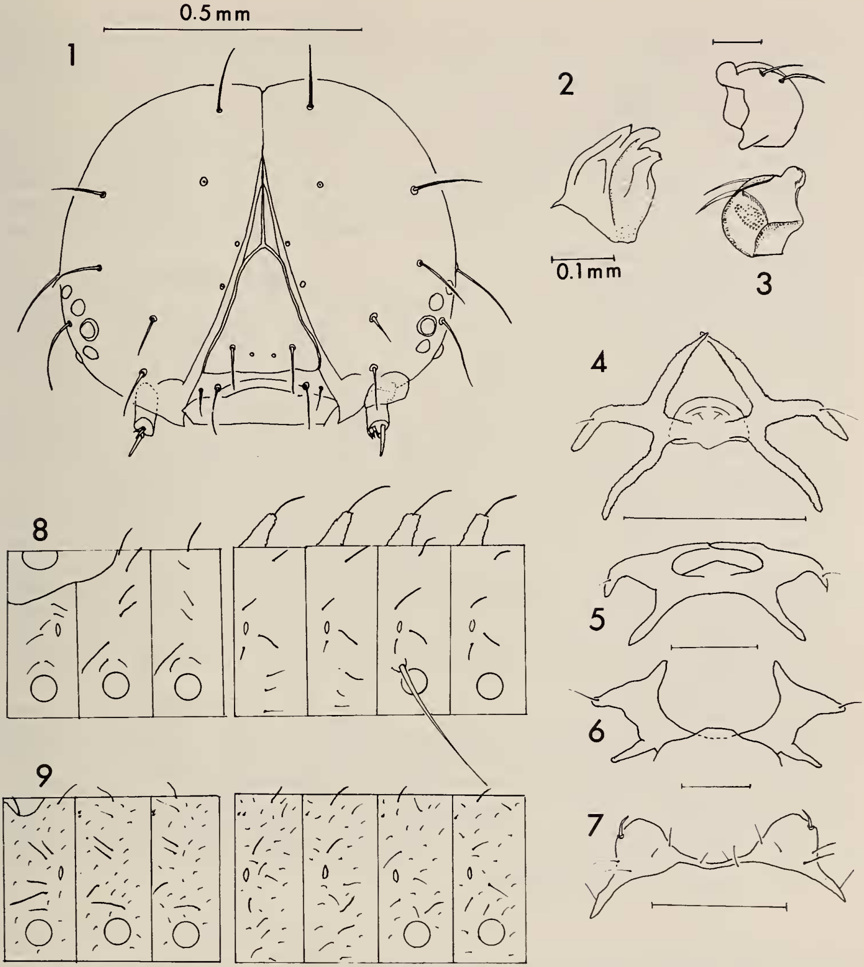
RESULTS

Litodonta hydromeli is multivoltine at Austin, and appears to be multivoltine in Florida also (Kimball 1965). As reported by Harvey (1876b), I found at least three broods to occur in March, April, and September. The moths overwintered as prepupae in the laboratory. Females laid eggs on the leaves and bark of *Bumelia*. Development lasted approximately six weeks from egg to prepupa. Eggs took six to seven days to develop. For all stages, intermolt time was approximately five days. Prepupae turned reddish, entered a wandering stage that lasted one day, burrowed into soil, and formed slight, silk cocoons within earthen pupal cells. In nonwintering individuals, time from prepupa to eclosion was about 17 days. Even in these, the prepupa did not immediately form a pupa within the cell. Emerging adults mated readily in captivity, and a second spring brood was obtained. The fall flight occurred in late August and early September.

Description of Stages

Egg (n = 4). Dome shaped; light blue-green, becoming yellow, then brown, before hatching. Diam. 0.99 mm. Chorion with fine, reticulate sculpturing.

First instar (n = 7). Length 3.1 (2.5–3.7) mm. Head dark brown. Body ground color dark reddish brown; with dark brown scoli and spines. Prolegs and ventral areas yellow green with red flecks, A10 proleg bright yellow. Head diam. 0.6 mm; height of frons 0.2 mm; length of epicranial suture 0.2 mm. Chaetotaxy as in Fig. 1. Mandibles with 3 fingerlike lobes (Fig. 2). Prothorax with dorsal, three-pronged scoli (Fig. 4); scoli rugose, sclerotized base extending to anterior margin of mesothorax; XD1 located on midpoint of second prong; XD2 on anterior margin of sclerotized base beneath and anterior to XD1; D1 between prongs on sclerotized base and D2 ventrad and on margin. Other thoracic primary setae as in Fig. 8. D1 of abdominal segments A1–A6, A8 and A10 on raised, serrate pinacula; SV1 of A3 extremely long, twice length of other setae, ventrally



FIGS. 1–9. *Litodonta hydromeli* larval morphology. **1,** Head chaetotaxy of first instar; **2,** First instar mandible; **3,** Fifth instar mandible; **4,** Prothoracic scoli of first instar; **5,** Prothoracic scoli of third instar; **6,** Prothoracic scoli of fourth instar; **7,** Prothoracic scoli of fifth instar; **8,** Chaetotaxy of thorax and A1 to A4 of first instar; **9,** Chaetotaxy of thorax and A1 to A4 of fifth instar. Scales represent 1 mm unless otherwise indicated.

directed. Prolegs on A3–A6 well developed, those on A10 reduced. Crochets uniordinal, uniserial. Chaetotaxy as in Fig. 8.

Second instar (n = 4). Length 3.6 (3.1–4.3) mm. Numerous scattered secondary setae present in this and all subsequent instars. Coloration similar to first instar. Head diam. 0.8 (0.8–0.9) mm; height of frons 0.2 (0.2–0.3) mm; length of epicranial suture 0.4 (0.3–0.4) mm. Mandibles with ridgelike cutting edge. Prothoracic scoli as in first instar but slightly reduced and more stout. D1 of segments A1–A6 and A8 on simple, raised pinacula; D1 of A10 on slightly raised pinacula; SV1 of A3 normal.

Third instar (n = 5). Length 11.1 mm (n = 2). Head dark brown; body green with sublateral white stripe. Head diam. 1.4 (1.2–1.5) mm; height of frons 0.4 (0.3–0.4) mm; length of epicranial suture 0.7 (0.6–0.8) mm; vertex slightly narrower than in previous instars. Prothoracic scoli reduced, but with three distinct prongs (Fig. 5). Opening of prothoracic gland visible. Coxae with spindle-shaped seta on cephalic, dorsal margin. D1 of A1–A6 on reduced pinacula; D1 of A8, A10 on flat pinaculi.

Fourth instar (n = 5). Length 13.1 mm (n = 3). Coloration similar to fifth instar. Head diam. 2.1 mm; height of frons 0.9 (0.8–1.1) mm; height of epicranial suture 1.1 (1.0–1.1) mm. Prothoracic scoli with reduced prongs (Fig. 6); adenosma well developed; spindle-shaped seta present on all thoracic coxae. D1 of all abdominal segments nearly indistinguishable from secondary setae. A10 prolegs completely reduced, with ring of setae surrounding undeveloped plantae.

Fifth instar (n = 7). Length 34 (32–36) mm. Head brown; body green with white flecks; prothoracic prominences brown; a broad, reddish brown (concolorous green in some individuals) dorsal stripe extending from prothorax to tenth segment; a faint, horizontal, sublateral, white stripe from prothorax to tenth segment; thin, horizontal, midventral and subdorsal white stripes on thorax. Abdominal segments with diagonal white stripes extending intersegmentally. Subventral and underside brown with white flecks. Head diam. 3.3 mm; height of frons 0.9 (0.8–1.1) mm; height of epicranial suture 1.6 (0.5–1.8) mm. Mandibles as in Fig. 3. Hypopharyngeal complex as in Fig. 10; clypeus deeply invaginated with two pairs of stout setae on tip, and two pairs of minute setae on underside. Six larval stemmata; O3 surrounded by enlarged, sclerotized ring. Chaetotaxy as in Fig. 11. XD1 of prothorax on a smooth, conical prominence (Fig. 7). Everted adenosma bifurcate (Fig. 12). Spindle-shaped coxal setae as in Fig. 13. Abdominal chaetotaxy as in Fig. 9, two md microsetae on first abdominal segment. Prolegs on A3 with 30 (21–33) crochets, on A4 with 34 (33–35) crochets, on A5 with 34 (32–37) crochets, on A6 with 35 (34–37) crochets.

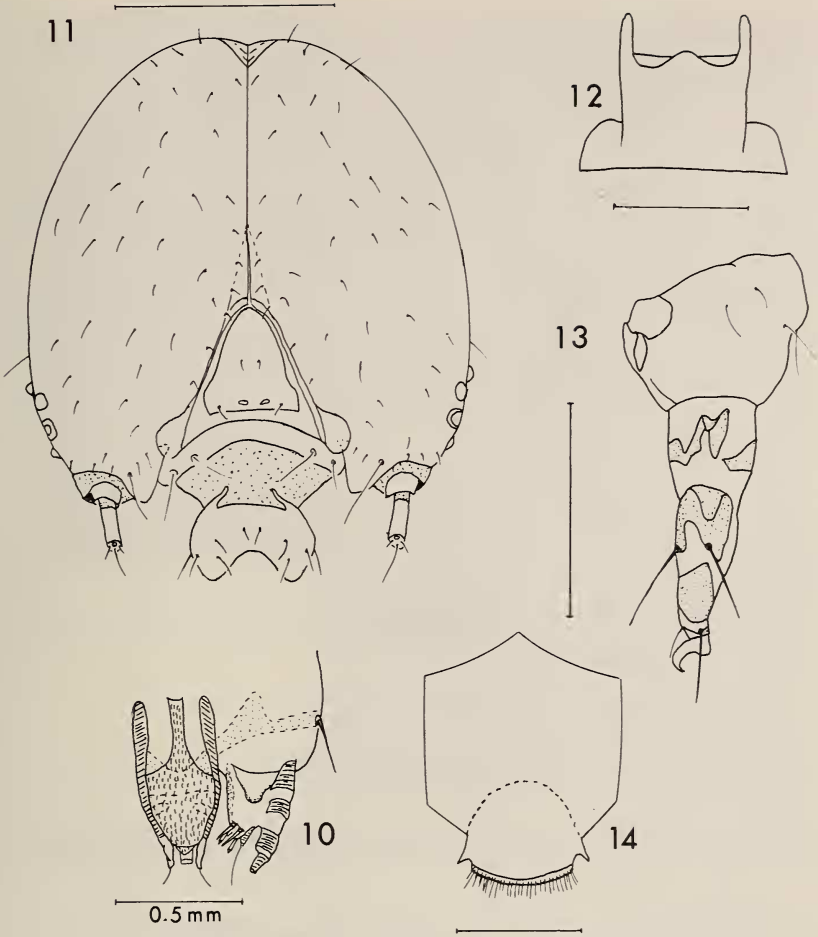
Pupa (n = 8). Length 18.2 (15.0–27.0) mm. Vertex with slight indentation. Tb1, Tb2, and Tar3 visible. Caudal edge of mesonotum with row of pits below ecdysial line of weakness. Spiracles with densely packed, short, recurved setae. Cremaster two oblique, outwardly pointing processes.

Adult. Ocelli absent; antenna ⅔ pectinate in both sexes, last 15 segments laminate, pectinations bicolored, black dorsally, ventral extension light brown. Epiphysis ¾ length of tibia. One pair of tibial spurs on mesothoracic legs; spurs with grooved inner surface extending more than ¾ spur length. Metathoracic tibia with two pairs of spurs; first pair with serrate ridges on inner tip surface approximately ⅓ spur length; second pair like mesothoracic one. All tarsi spinose; 5th tarsomere with 2 long, dorsolateral setae. Claws bifid. Male eighth sternite as in Fig. 14; male genitalia as in Figs. 15, 16. Female genitalia as in Fig. 17. Female wing with 5 frenular bristles.

DISCUSSION

Three chaetotaxic changes occur among instars in *Litodonta hydromeli*. First, a spindle-shaped seta on the thoracic coxae appears in the third, fourth, and fifth instars. The function of this seta is unknown. It occurs in mature larvae of *Furcula borealis* (Guér.-Méneville), *Heterocampa astartioides* Benjamin, *Schizura unicornis* (J. E. Smith), *Hyparpax aurora* (J. E. Smith), and *Disphragis* sp.; but not in *Dasylophia* sp., *Symmerista albifrons* (J. E. Smith), *Lochmaeus bilineata* (Packard), *Hapigia* sp., and *Misogada unicolor* (Packard).

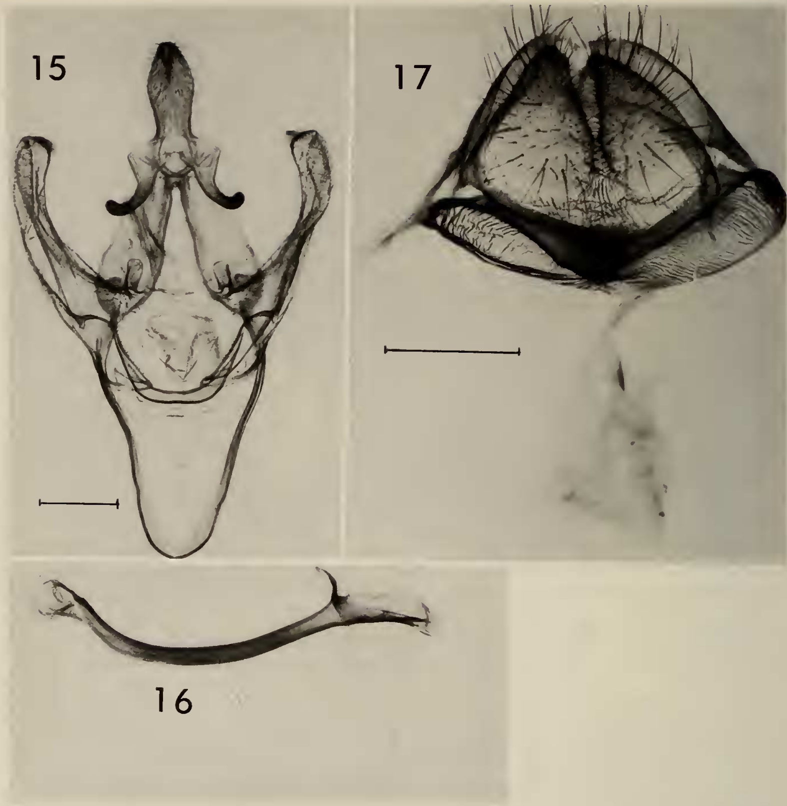
Other setal differences between first and subsequent instars of *Litodonta hydromeli* concern secondary setae and length of SV1 on the first abdominal proleg. Scattered, short, secondary setae occur on the head and body in second and later instars. There are secondary setae on larval prolegs in all instars. In the first instar, SV1 on the first



FIGS. 10–14. *Litodonta hydromeli* larval and adult morphology. **10,** Hypopharyngeal complex of fifth instar; **11,** Head chaetotaxy of fifth instar; **12,** Everted adenosma of fifth instar; **13,** Prothoracic leg of fifth instar; **14,** Adult male eighth sternite. Scales represent 1 mm unless otherwise indicated.

abdominal proleg is twice as long as other SV setae (Fig. 8). In all other instars, SV1 is the same length as other SV setae.

Litodonta hydromeli pupae possess a character found in other North American Heterocampini. Mosher (1917) described the row of deep pits on the pupal thoracic dorsum in *Schizura ipomoeae* (Doubleday), *S. concinna* (J. E. Smith), *Heterocampa guttivitta* (Walker), and *Lochmaeus bilineata* (Packard). These pits also occur in *Schizura unicornis* (J. E. Smith), *Disphragis* sp. (Ecuador, culture No. WE84-007), *Hyparpax aurora* (J. E. Smith), *Heterocampa astartioides*, and one species



FIGS. 15–17. *Litodonta hydromeli* genitalia. **15,** Male genitalia except aedeagus; **16,** Aedeagus; **17,** Female genitalia. Figs. 15 and 16 are same scale. Scales represent 1 mm.

of Nystaleini, *Strophocerus punctulum* (Schaus). The taxonomic distribution of this character needs further study.

Like *Litodonta hydromeli,* some larval Heterocampini possess elaborate spines in the early instars (Packard 1895), and develop ventral, prothoracic defense glands which become functional in later stages (Herrick & Detwiler 1919, Eisner et al. 1972). Secretions of these glands in *Schizura concinna* and *Lochmaeus manteo* (Doubleday) contain a mixture of formic acid and straight-chain ketones (Eisner et al. 1972, Weatherston et al. 1979). These secretions deter invertebrates and vertebrates (Eisner et al. 1972). Notodontids are the only lepidopterans known to produce defense compounds containing ketones (Blum 1981).

During larval development of *Litodonta hydromeli,* a progressive reduction in the dorsal armature occurs concurrently with the development of the ventral, prothoracic defense gland. The gland can be dissected out of second and later instars. It is the same shape as that of *Schizura concinna* (Weatherston et al. 1979). The spray of fifth instars has a strong, acidic odor and deters *Atta texana* (Buckley) (Weller unpubl.). The ants vigorously clean their antennae after encountering a larva. However, the spray is not effective against another local ant, *Camponotis* sp.

In addition to ontogeny of defense structures, ontogeny of feeding behavior occurs. Changes in feeding behavior during larval development are correlated with changes in mandibular morphology. First instars feed on the upper surface of the leaf and skeletonize it with forklike mandibles (Fig. 3), whereas subsequent instars ingest the entire leaf, and fifth instar mandibles have a thin, ridged, cutting edge and an inner, roughened surface (Fig. 4). Similar feeding behavior changes are known for several notodontid species (Godfrey & Appleby 1987).

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